

PEER REVIEW HISTORY

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ARTICLE DETAILS

TITLE (PROVISIONAL)	Objectively measured physical activity in Finnish employees: a cross-sectional study
AUTHORS	Kujala, Urho; Mutikainen, Sara; Helander, Elina; Pietilä, Julia; Korhonen, Ilkka

VERSION 1 - REVIEW

REVIEWER	Tuija Tammelin LIKES - Research Center for Sport and Health Sciences, Finland
REVIEW RETURNED	17-Aug-2014

GENERAL COMMENTS	<p>Manuscript is generally well written and clear. Results provide important novel information about objectively measured physical activity (PA) among Finnish working aged people. Main strengths of the study includes large study population and the use of novel objective method to measure PA and study. The associations between objectively measured PA and obesity levels seems to be the main findings in this study. The representativeness of the study population is not clear, and therefore more information is requested from the authors about the participants in this study and about some details related to PA measurement.</p> <p>The title:</p> <ul style="list-style-type: none">– Authors could add the aim to describe PA by obesity levels into the title. Now the title refers only to PA levels, but the manuscript largely describes the PA levels in different obesity groups. <p>Abstract:</p> <ul style="list-style-type: none">– Basic information about the proportion of men and women meeting the recommendations of aerobic PA could be added in results section of the abstract. <p>Methods/Study design and participants:</p> <ul style="list-style-type: none">– More background information for study population is needed. Authors statement about “wide range of non-manual and manual labor employees” (page 6 row 46, page 15 row 25) does not describe the study participants detailed enough to be able to make conclusions about the representativeness of the study population in respect to general population of Finnish adults or employees. There may be e.g. higher proportion of highly educated employees who have been offered/interested to participate in this service offered by occupational health care. It would be useful to have information on the educational level, socioeconomic status or occupation of participants or the physical work load at work.– In addition, what was the context (when and how) where employees were offered to participate in the heart rate monitoring? Were all employees in the companies offered monitoring or only part of employees for some reason?
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	<ul style="list-style-type: none"> - What was the level of self-reported physical activity of the study population? - What was the season of the monitoring? Were all months of the year equally represented? <p>Methods/Physical activity assessment:</p> <ul style="list-style-type: none"> - Authors write that participants also reported their physical activity. What were the exact questionnaires used for self-reported PA and what was the distribution of population in different PA categories? Authors refer to the references 17 and 18. Which methods and what versions were used? - Authors state that HR max and estimated VO2max were further used in the estimation of VO2 during exercise. How did authors estimate the maximal HR (equation?) and maximal VO2 based on background information? What is the accuracy of these estimations (maximal HR and VO2)? - One strength of the heart rate monitoring compared to accelerometers is that by heart rate monitoring physical activity during cycling and gym-training is also included. Cycling is very common type of daily physical activity in Finland and is therefore essential to be included. - How participants were instructed about water sports? Was heart rate monitored during swimming and other water activities? <p>Other:</p> <ul style="list-style-type: none"> - Authors write in several cases about meeting the current recommendation of physical activity. However, it should be mentioned that they refer to recommendations of aerobic physical activity. Recommendations of health enhancing physical activity also include recommendations related to strength training.
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REVIEWER	Jani Vaara National Defence University, Helsinki, Finland
REVIEW RETURNED	10-Sep-2014

GENERAL COMMENTS	<p>Mutikainen et al. have conducted a cross-sectional study of physical activity in Finnish employees measured objectively. This is an interesting study with a large sample size including large range in age and BMI. It is one of the few studies that have assessed physical activity objectively with very large sample size including both genders. The methodology for assessing physical activity is different from other studies that have objectively measured physical activity, which is mainly done by using accelerometers. The manuscript is well written and statistical analysis do provide a basis for answering the study objectives. However, there are some issues I would like to address.</p> <p>P. 4 Rows 15-27: Bullets numbers 2-3 present results not strength and limitations of the study. This should be corrected according to the title.</p> <p>P.5 Rows 6-11: Physical activity elicits multiple health benefits other than just preventing body fat accumulation and type 2 diabetes. The authors could give examples in more broad overview on benefits of physical activity on health.</p> <p>P.6 rows 46-48 & P.15 rows 25-26. The representativeness of the study sample to typical national employees may be overly stated at</p>
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	<p>least without any statistical comparisons or detailed description. The authors should describe at least the proportion of non-manual and manual labor employees in this study sample. Furthermore, to prove the representation of the sample to nation wide employees the authors should make statistical comparisons of non-manual and manual employees from the national data register. If this is not done, the representativeness should not be mentioned.</p> <p>Another important issue relating to study sample is how selectively participants have participated in the present study? Is there a selection to those who are interested in their health and want to improve their health behavior, therefore leading to mainly healthy subjects? Or is this the other way round? Explain in more detail, what is the preventive occupational health care provided by employers and how the participants were chosen or how they took part in it. Another limitation to these analysis (which the authors have however addressed as a limitation) is a reporting of diseases and medication use in this study sample. Neither this information was included in the statistical analyses. The authors need to give a rational why they were not adjusted in the analyses and present a detailed numbers and/or proportions of the participants using medication or having diseases? Moreover, the authors state that the participants were apparently healthy. Is this information that authors did not directly assess? And if not, why it was not assessed in more detail than described in the methods (P.7 rows:15-37)?</p> <p>P.9 rows: 24-26 & 44-46. The authors have used three different classification of physical activity according the MET-values: MPA, VPA and MVPA. However, the results are reported for VPA and MVPA. If MPA is not used it should be removed from the methods.</p> <p>P.9 rows:46-55. The authors cite physical activity guidelines in assessing 10-min bouts which is highly relevant, however they have used a segment which allows 1 minute segment below the given threshold during that 10 min period. This do not seem logical – why not simply using a continuous 10 minute period above the threshold as described in physical activity guidelines?</p> <p>P11 Rows: 37-45 To study the number of participants full filling the PA guidelines of moderate intensity (150 min) the authors have extrapolated PA and used a a calculation to estimate this. The authors should emphasize more in the discussion that this is an estimation and discuss the validity of this estimation. This is given that physical activity can vary markedly between seasons, months, weeks and especially between days.</p> <p>In the figure 1 there are 61 individuals that are dropped from the final sample due to insufficient coverage of the monitoring days. This study sample consists of total of 14 451 measured days. Is this correct? The mean of measured days would then result as 236,9 days in total for a given individual?</p> <p>In the discussion, there could be a comparison of the proportion of physically active individuals in the present study and other previous nationally representative studies. This is especially important considering that previous studies have mainly assessed physical activity by questionnaire. Therefore, if accepting that the present study sample is nationally representative the difference could be argued to be effected by the methodology of the physical activity</p>
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	<p>assessment.</p> <p>In the validation study by Smolander et al. there was a rather small sample size and it consisted of young and apparently healthy participants. The authors should address more carefully that the validation study have focused on different kind of study sample than in this manuscript (large range of age and BMI). More specifically, discussion is needed whether this result of Smolander et al. is valid result for example for overweight and obese individuals ,and unfit/fit individuals. This should be discussed in more details. In addition, the authors should present the percentage of normal weight , overweight and obese individuals of the present study sample.</p> <p>The manuscript consists of very large sample size, which is a major strength, however, this results in much information as well. The manuscript could be improved to make it easier for the reader to go through the paper (there are a total of 11 tables and figures!). Therefore, the authors should definitely show only the essential tables and figures. Now there is duplicate information in tables and figures. For example figures 1-5 show partially the same results than tables 1-5. The authors should only use either one. In either case, it is essential to include either median or 95% CI for a given variable.</p> <p>Moreover, the authors might want to reconsider presenting the figures in a similar scales for the sum of 1-min and 10-min bouts. This would make it easier for the reader to capture the differences of proportions between these two conditions.</p> <p>The authors should add more specific information to tables 4-5. Coefficients are apparently beta-coefficients? This should be mentioned. Also whether these are standardized beta-coefficients should be mentioned. Moreover, what are the specific models used in the table 5? Which variables were in the models simultaneously in the table 5?</p>
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REVIEWER	Neville Owen Baker IDI Heart and Diabetes Institute, Melbourne, Australia
REVIEW RETURNED	17-Sep-2014

GENERAL COMMENTS	<p>In relation to question 5 above, I have raised an issue for the editor and queried the authors about what appears to be 'consent by proxy' through service providers rather than being direct consent from the study participants themselves. This might be OK with further explanation.</p> <p>This is a very interesting paper that uses a novel method to identify variations in participation in moderate and vigorous physical activity in a large sample of working adults. It is well written and the methods are described with considerable clarity and precision. It is something of a blockbuster – there are far more tables and figures than one would normally encounter. It wasn't apparent to me which of the tables of figures might be deleted for the purposes of brevity.</p> <p>Overall, this is a significant and interesting contribution and is informative for the field. The novel measurement method used is referenced through multiple reports and documented patents that are available online.</p>
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	<p>What is described is, however, well outside of my particular knowledge and expertise, so it would be good if the journal had available an evaluation by someone who is expert in the physiological measurements involved in deriving activity-intensity indices from heartbeat monitoring.</p> <p>The meticulous way in which all aspects of the paper are addressed is impressive. The scientific work described and the overall write-up of the findings are both of a very high standard, for which the authors deserve considerable credit. It's difficult to find faults – either minor or major – with their exposition in this paper</p> <p>This is a well written paper that describes a scientifically-novel method for determining participation in moderate and vigorous physical activity. The study has a large sample size and there is interesting descriptive information on attributes of participants. There are some matters to which the authors should attend, in order to improve some aspects of how their work is presented and interpreted:</p> <ol style="list-style-type: none"> 1. Could further reassurance be provided that ethical matters were attended to appropriately. It appears that the participant-consent procedure may have been 'consent by proxy', through the service providers with whom study participants had contact. It would be reassuring for the reader if there were to be more information provided on how this consent procedure adhered to national requirements and international standards of informed consent for research study participants. 2. It seems likely that the consistent pattern lower levels of moderate and vigorous activity on working days is related to the requirement that many workers will have to sit at desks and in front of computers for long hours during their working days. There is new evidence that prolonged sitting specifically may be a significant occupational health hazard that requires attention. Given the large volume of time involved, reducing sitting time may have greater potential for improving health than might be achieved through the relatively limited opportunities that could exist for increasing moderate and vigorous physical activity. The authors allude to the likely importance of lower-intensity activity. Perhaps there could be some consideration of this in the discussion? 3. Could further consideration also be given to the recommendation that for overweight and obese individuals, moderate-intensity activity be addressed first? Given the modest amounts of MPA and VPA that are identified, particularly so for those who are overweight or obese and those who are older, might it not be more realistic and potentially more beneficial for these very inactive people to reduce their sitting time and increase their light-intensity physical activity?
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VERSION 1 – AUTHOR RESPONSE

Reviewer: 1

Reviewer Name Tuija Tammelin

Institution and Country LIKES - Research Center for Sport and Health Sciences, Finland

Please state any competing interests or state 'None declared': None declared

Manuscript is generally well written and clear. Results provide important novel information about objectively measured physical activity (PA) among Finnish working aged people. Main strengths of the study includes large study population and the use of novel objective method to measure PA and study. The associations between objectively measured PA and obesity levels seems to be the main findings in this study. The representativeness of the study population is not clear, and therefore more information is requested from the authors about the participants in this study and about some details related to PA measurement.

Authors' response: Thank you for the overall positive comment on our manuscript. Our detailed responses are given below.

The title:

- Authors could add the aim to describe PA by obesity levels into the title. Now the title refers only to PA levels, but the manuscript largely describes the PA levels in different obesity groups.

Authors' response: We agree that PA by obesity was our main interest and these findings may be the most interesting for the readers. However, as BMI is only one of the determinants of PA investigated in our study we prefer the shorter version of the title and prefer to mention BMI in the aims. This is because we think that there is still a need for even deeper analysis of inactivity/activity levels by BMI in this material, and this first paper on the large material covers much larger descriptive scope (by age, by gender, by the type of day).

Abstract:

- Basic information about the proportion of men and women meeting the recommendations of aerobic PA could be added in results section of the abstract.

Authors' response: The percentages of men and women fulfilling the recommendation are given in the abstract, but due to the word limit, more detailed information can't be included.

Methods/Study design and participants:

- More background information for study population is needed. Authors statement about "wide range of non-manual and manual labor employees" (page 6 row 46, page 15 row 25) does not describe the study participants detailed enough to be able to make conclusions about the representativeness of the study population in respect to general population of Finnish adults or employees. There may be e.g. higher proportion of highly educated employees who have been offered/interested to participate in this service offered by occupational health care. It would be useful to have information on the educational level, socioeconomic status or occupation of participants or the physical work load at work.

Authors' response: We fully agree on this and have identified this as a weakness. Unfortunately, in this data mining type register study we do not have reliable individual level information about these factors in our analysis files constructed according to the plan accepted by the ethics committee. Therefore this information cannot be made available and this is a clear limitation of our study. We have added a comment about this limitation to our discussion. The activity recording itself shows the level of physical aerobic loading of the participants. It is to note that due to the advanced technology, in today's society the name of the occupation does not give exact information on the physical loading of work. Our study may include participants who would have not participated in a population survey, but it is not a population-based sample and does not include unemployed individuals as work-day recordings are an inclusion criterion.

- In addition, what was the context (when and how) where employees were offered to participate in the heart rate monitoring? Were all employees in the companies offered monitoring or only part of

employees for some reason?

Authors' response: Employees were offered to participate in the heart rate monitoring in the preventive occupational health care provided by their employers, as described in the Methods. According to Firstbeat Technologies Ltd usually all employees in a place of employment are offered to participate in the monitoring, but there are some exceptions including that sub-groups or individuals with potentially high mental work-related loading may be selected to the monitoring. However, the selection is usually not made on the basis of low or high physical activity level.

– What was the level of self-reported physical activity of the study population?

Authors' response: The distribution of self-reported physical activity classes in the study population is described in the table below. Most of the participants have their self-reported physical activity class between 3 and 7. The most common self-reported physical activity class is 6 among men and 3 among women.

We have not presented this information in the manuscript since there has been slight change in the questionnaire used to ask self-reported physical activity during the time period included in this study. Additionally, our aim was to report objectively measured physical activity including activity at work and leisure time. We are not focusing on reporting association between objective measures and self-reported physical activity (which is usually leisure time physical activity) since it is an issue which should be addressed more specifically in another study design.

Self-reported

physical

activity

class Men Women

n (%) n (%)

0 43 (1.0) 57 (1.1)

1 133 (3.2) 142 (2.7)

2 325 (7.7) 383 (7.2)

3 677 (16.0) 1021 (19.1)

4 532 (12.6) 801 (15.0)

5 640 (15.2) 826 (15.5)

6 830 (19.7) 1013 (19.0)

7 591 (14.0) 702 (13.2)

7.5 250 (5.9) 210 (3.9)

8 130 (3.1) 109 (2.0)

8.5 43 (1.0) 37 (0.7)

9 20 (0.5) 19 (0.4)

9.5 2 (0.1) 7 (0.1)

10 5 (0.1) 6 (0.1)

0=no regular participation in recreational sports or heavy physical activity (always avoid exertion, whenever possible)

1=no regular participation in recreational sports or heavy physical activity (walk for pleasure, routinely use stairs, occasionally exercise sufficiently to cause heavy breathing or sweating)

2=regular participation in recreation or work requiring modest physical activity (10-60 min per week)

3=regular participation in recreation or work requiring modest physical activity (over 1 hour per week)

4=regular participation in heavy physical exercise 2-5 times a week (less than 30 min per week)

5=regular participation in heavy physical exercise 2-5 times a week (30-60 min per week)

6=regular participation in heavy physical exercise 2-5 times a week (1-3 hours per week)

7=regular participation in heavy physical exercise 2-5 times a week (3-5 hours per week)

7.5=regular participation in heavy physical exercise 2-5 times a week (5-7 hours per week)

8=training almost daily (for a regional level endurance athlete VO2max female >59 ml/kg/min, male >65 ml/kg/min) (7-9 hours per week)
 8.5=training daily (for a national level endurance athlete VO2max female >63 ml/kg/min, male >69 ml/kg/min) (9-11 hours per week)
 9=training daily (for a national level endurance athlete VO2max female >63 ml/kg/min, male >69 ml/kg/min) (11-13 hours per week)
 9.5=training daily (for an international level endurance athlete VO2max female >71 ml/kg/min, male >77 ml/kg/min) (13-15 hours per week)
 10=training daily (for an international level endurance athlete VO2max female >71 ml/kg/min, male >77 ml/kg/min) (more than 15 hours per week)

The correlation coefficient (Spearman's rho) between the amount of objectively measured physical activity and the self-reported physical activity class is shown in the table below for men and women during workdays and days off.

Men Women

Workdays Days off Workdays Days off

MVPA1min 0.33 0.30 0.52 0.48

VPA1min 0.44 0.35 0.52 0.45

MVPA10min 0.37 0.31 0.47 0.41

VPA10min 0.36 0.30 0.37 0.32

MVPA1min=moderate-to-vigorous physical activity (≥ 3 metabolic equivalents [METs]) calculated from single 1-minute bouts throughout the measurement period

VPA1min=vigorous physical activity (≥ 6 METs) calculated from single 1-minute bouts throughout the measurement period

MVPA10min= moderate-to-vigorous physical activity (≥ 3 METs) calculated from bouts of physical activity lasting continuously for ≥ 10 minutes

VPA10min=vigorous physical activity (≥ 6 METs) calculated from bouts of physical activity lasting continuously for ≥ 10 minutes

Among women, the self-reported physical activity class correlates best with MVPA1min and VPA1min during workdays. Among men, the self-reported physical activity class correlates best with VPA1min during workdays. Overall, the correlation coefficients between the self-reported physical activity class and the amount of objectively measured physical activity are higher in women than in men.

– What was the season of the monitoring? Were all months of the year equally represented?

Authors' response: There were measurements from all seasons and months of the year. However, the months of the year were not equally represented in the data. The autumn (September, October, November) and winter (December, January, February) months were quite equally represented in the data, whereas the spring months (March, April, May) were slightly over-represented and the summer months (June, July, August) (which are the most common holiday months in Finland) were naturally under-represented in the data according to our study design. The detailed distribution of the months of measurements is shown in the following table.

Men Women

Number (and percentage) of measurement days

January 1115 (9.1) 1441 (9.2)

February 1236 (10.1) 1798 (11.5)

March 1599 (13.0) 2451 (15.7)

April 1111 (9.0) 1452 (9.3)

May 1703 (13.9) 1872 (12.0)

June 811 (6.6) 991 (6.3)
July 136 (1.1) 88 (0.6)
August 463 (3.8) 549 (3.5)
September 1139 (9.3) 1724 (11.0)
October 950 (7.7) 1209 (7.7)
November 1203 (9.8) 1284 (8.2)
December 812 (6.6) 799 (5.1)

Methods/Physical activity assessment:

– Authors write that participants also reported their physical activity. What were the exact questionnaires used for self-reported PA and what was the distribution of population in different PA categories? Authors refer to the references 17 and 18.

Which methods and what versions were used?

Authors' response: We used a modification of the original scale of Ross and Jackson which has now been described in methods. See above.

– Authors state that HR max and estimated VO₂max were further used in the estimation of VO₂ during exercise. How did authors estimate the maximal HR (equation?) and maximal VO₂ based on background information? What is the accuracy of these estimations (maximal HR and VO₂)?

Authors' response: HR max is calculated based on equation $210 - 0.65 \times \text{age}$ (Jones NL. Clinical exercise testing. 3rd ed. Philadelphia: W.B.Saunders, 1988). If higher HR (with certain duration at that HR level) is found from the recording, the person's HR max is corrected accordingly. Non-exercise based equation for VO₂max by Jackson et al. is used in the analysis (Jackson et al. Prediction of functional aerobic capacity without exercise testing. Med Sci Sports Exerc 1990;22:863-870). We have added these references to the Methods section.

– One strength of the heart rate monitoring compared to accelerometers is that by heart rate monitoring physical activity during cycling and gym-training is also included. Cycling is very common type of daily physical activity in Finland and is therefore essential to be included.

Authors' response: We agree. Cycling and gym-training are included.

– How participants were instructed about water sports? Was heart rate monitored during swimming and other water activities?

Authors' response: The monitor is not used during watersports. As we excluded the recordings with longer breaks, the recording days with longer watersports sessions are excluded. We have added to the manuscript that the heart rate monitor used in our study cannot be used during watersports.

Other:

– Authors write in several cases about meeting the current recommendation of physical activity. However, it should be mentioned that they refer to recommendations of aerobic physical activity. Recommendations of health enhancing physical activity also include recommendations related to strength training.

Authors' response: Thank you for this comment. We agree. We have corrected this to our manuscript throughout the text.

Reviewer: 2

Reviewer Name Jani Vaara

Institution and Country National Defence University, Helsinki, Finland

Please state any competing interests or state 'None declared': None declared

Mutikainen et al. have conducted a cross-sectional study of physical activity in Finnish employees measured objectively. This is an interesting study with a large sample size including large range in age and BMI. It is one of the few studies that have assessed physical activity objectively with very large sample size including both genders. The methodology for assessing physical activity is different from other studies that have objectively measured physical activity, which is mainly done by using accelerometers. The manuscript is well written and statistical analysis do provide a basis for answering the study objectives. However, there are some issues I would like to address.

Authors' response: Thank you for the overall positive comment on our manuscript.

P. 4 Rows 15-27: Bullets numbers 2-3 present results not strength and limitations of the study. This should be corrected according to the title.

Authors' response: We have deleted bullet numbers 2-3 from the manuscript.

P.5 Rows 6-11: Physical activity elicits multiple health benefits other than just preventing body fat accumulation and type 2 diabetes. The authors could give examples in more broad overview on benefits of physical activity on health.

Authors' response: We agree that there is much suggestive data on many health benefits on the basis of observational studies and we have added these results to the introduction. However, it is to note that there is no confirmatory evidence available from RCTs that physical activity prevents from such chronic diseases as coronary heart disease or dementia, or mortality.

P.6 rows 46-48 & P.15 rows 25-26. The representativeness of the study sample to typical national employees may be overly stated at least without any statistical comparisons or detailed description. The authors should describe at least the proportion of non-manual and manual labor employees in this study sample. Furthermore, to prove the representation of the sample to nation wide employees the authors should make statistical comparisons of non-manual and manual employees from the national data register. If this is not done, the representativeness should not be mentioned.

Authors' response: Unfortunately, in this data mining type register study we do not have reliable individual level information about these factors in our analysis files constructed according to the plan accepted by the ethics committee. Therefore this information cannot be made available and this is a clear limitation of this type of data mining study. We have added a comment about this limitation to our discussion and have deleted the sentence on the good representativeness. It is to note that due to the advanced technology, in today's society the name of the occupation does not give exact information on the physical loading of work. Our study may include participants who would have not participated in a population survey, but it is not a population-based sample and does not include unemployed individuals as work-day recordings are an inclusion criterion.

Another important issue relating to study sample is how selectively participants have participated in the present study? Is there a selection to those who are interested in their health and want to improve their health behavior, therefore leading to mainly healthy subjects? Or is this the other way round? Explain in more detail, what is the preventive occupational health care provided by employers and how the participants were chosen or how they took part in it.

Authors' response: Employees were offered to participate in the heart rate monitoring in the preventive occupational health care provided by their employers, as described in the Methods. According to Firstbeat Technologies Ltd usually all employees in a place of employment are offered to participate in the monitoring, but there are some exceptions including that sub-groups or individuals with potentially high mental work-related loading may be selected to the monitoring. However, the selection is usually not made on the basis of low or high physical activity level.

Another limitation to these analysis (which the authors have however addressed as a limitation) is a reporting of diseases and medication use in this study sample. Neither this information was included in the statistical analyses. The authors need to give a rational why they were not adjusted in the analyses and present a detailed numbers and/or proportions of the participants using medication or having diseases? Moreover, the authors state that the participants were apparently healthy. Is this information that authors did not directly assess? And if not, why it was not assessed in more detail than described in the methods (P.7 rows:15-37)?

Authors' response: In this data mining type register study we unfortunately do not have reliable individual level information on medications and diseases in our analysis files constructed according to the plan accepted by the ethics committee and that is why we have not taken these factors into account in the analyses. We have added a comment about this to the discussion. The exclusion criteria according to chronic diseases are explained in the methods.

P.9 rows: 24-26 & 44-46. The authors have used three different classification of physical activity according the MET-values: MPA, VPA and MVPA. However, the results are reported for VPA and MVPA. If MPA is not used it should be removed from the methods.

Authors' response: We have not mentioned results for MPA in the text, but we have reported some results for it in the Figures 2 and 3. That is why we have described also MPA in the Methods section.

P.9 rows:46-55. The authors cite physical activity guidelines in assessing 10-min bouts which is highly relevant, however they have used a segment which allows 1 minute segment below the given threshold during that 10 min period. This do not seem logical – why not simply using a continuous 10 minute period above the threshold as described in physical activity guidelines?

Authors' response: When individuals report participating in such physical activities as cross-country skiing, cycling, gym-training etc., it is common that there are short periods when the heart rate slows down due to downhill during cross-country skiing, traffic light during cycling, recovery breaks during gym-training etc. However, these types of training sessions are usually reported as continuous exercise sessions. Also, other researchers have discussed this issue: The study of Mâsse et al. (Accelerometer data reduction: A comparison of four reduction algorithms on select outcome variables. *Med Sci Sports Exerc* 2005;37(11 Suppl):S544-S554) reported that allowing a 1- or 2-minute interruption anytime during the bout of physical activity resulted in higher amounts of moderate-to-vigorous physical activity than did allowing no interruption. Since short breaks are plausible during longer bouts of physical activity, they suggested that a 1- or 2-minute interruption could be reasonable to include when assessing physical activity. The study of Miller et al. (Effect of varying accelerometry criteria on physical activity: The Look AHEAD Study. *Obesity* (Silver Spring) 2013;21(1): doi:10.1002/oby.20234) supports these findings. That is why we have preferred to calculate the amount of physical activity allowing a 1-minute interruption during a 10-minute period. We also calculated the differences between the amounts of MVPA and VPA calculated so that no interruption was allowed ("no interruption approach") and one 1-minute interruption ("1-min interruption approach") during a 10-minute period was allowed. The mean (SD) difference between the "no interruption approach" and "1-min interruption approach" is 3.2 (6.4) minutes for the amount of MVPA and 0.7 (2.7) minutes for the amount of VPA. In other words, the amount of MVPA and VPA

was slightly greater when “1-min interruption approach” was used. A more detailed description about the differences is given below.

During workdays, 39.4% of the participants (45.6% of male participants and 34.5% of female participants) and during days off 35.0% of the participants (43.4% of male participants and 28.4% of female participants) had MVPA10min which included at least one 1-min segment in which the intensity level was <3 METs. Among the participants, whose MVPA10min included at least one <3 METs segment, the mean (SD) number of <3 METs segments was 8.2 (7.9) [men: 8.7 (8.5); women: 7.6 (7.0)] during workdays and 12.0 (11.1) [men: 13.2 (12.2); women: 10.5 (9.3)] during days off.

During workdays, 12.0% of the participants (15.9% of male participants and 8.9% of female participants) and during days off 9.9% of the participants (14.0% of male participants and 6.6% of female participants) had VPA10min which included at least one 1-min segment in which the intensity level was <6 METs. Among the participants, whose VPA10min included at least one <6 METs segment, the mean (SD) number of <6 METs segments was 6.2 (5.1) [men: 6.5 (5.3); women: 5.8 (4.8)] during workdays and 9.8 (8.1) [men: 10.2 (8.6); women: 9.2 (7.2)] during days off.

P11 Rows: 37-45

To study the number of participants full filling the PA guidelines of moderate intensity (150 min) the authors have extrapolated PA and used a calculation to estimate this. The authors should emphasize more in the discussion that this is an estimation and discuss the validity of this estimation. This is given that physical activity can vary markedly between seasons, months, weeks and especially between days.

Authors' response: We have added a more strong comment to the discussion that we have used an estimation method to this purpose.

In the figure 1 there are 61 individuals that are dropped from the final sample due to insufficient coverage of the monitoring days. This study sample consists of total of 14 451 measured days. Is this correct? The mean of measured days would then result as 236,9 days in total for a given individual?

Authors' response: There were 61 individuals who were completely dropped from the analysis due to this problem, but also among the other 12 806 individuals there were days that were not included to our analyses due to this coverage reason. In most cases dropping one day did not lead to dropping the individual as proper recordings from work days and days-off were still available. This is why the number of monitoring days and number of individuals are given separately in the flow chart.

In the discussion, there could be a comparison of the proportion of physically active individuals in the present study and other previous nationally representative studies. This is especially important considering that previous studies have mainly assessed physical activity by questionnaire. Therefore, if accepting that the present study sample is nationally representative the difference could be argued to be effected by the methodology of the physical activity assessment.

Authors' response: In addition to deleting the comment on good representativeness we have added a comment on this topic to the discussion. However, it should be noted that the respondents to questionnaire-based studies may predominantly consider only leisure time physical activity while our objective measures include also activities at work.

In the validation study by Smolander et al. there was a rather small sample size and it consisted of young and apparently healthy participants. The authors should address more carefully that the validation study have focused on different kind of study sample than in this manuscript (large range of age and BMI). More specifically, discussion is needed whether this result of Smolander et al. is valid result for example for overweight and obese individuals ,and unfit/fit individuals. This should be discussed in more details. In addition, the authors should present the percentage of normal weight ,

overweight and obese individuals of the present study sample.

Authors' response: First, it is to note that the validation study of Smolander et al. was just one validation study and the development of the method has been based on wide range of subjects. It is correct that the sample size in Smolander et al. was limited and contained young, healthy adults. As emphasized in Smolander et al. estimating of VO₂max from HR-derived information is not an easy task and there are several factors that affect the accuracy of estimations such as fitness, age, gender, and body weight. However, these all were taken into account by the present method when producing an estimate for VO₂max according to non-exercise equations by Jackson et al. 1990. Moreover, individual HR range is used by the method, and the results are further improved by using on/off response and HRV-derived respiration rate in the calculations for momentary VO₂. As non-exercise equations are used and no calibration tests at a laboratory are performed, it is clear that the VO₂ estimates cannot be as accurate as in the laboratory settings. However, as emphasized also by Smolander et al., the method is sufficiently accurate for field-use. The number of participants by gender and BMI class are shown in Table 3.

The manuscript consists of very large sample size, which is a major strength, however, this results in much information as well. The manuscript could be improved to make it easier for the reader to go through the paper (there are a total of 11 tables and figures!). Therefore, the authors should definitely show only the essential tables and figures. Now there is duplicate information in tables and figures. For example figures 1-5 show partially the same results than tables 1-5. The authors should only use either one. In either case, it is essential to include either median or 95% CI for a given variable.

Authors' response: We have tried to make our figures informative and easy to interpret, and therefore we have included the numbers of participants in each group and additional detailed statistical information into the tables. There is indeed overlapping between the figures and tables 1-3; our original idea was to place tables 1-3 as supplementary files. As this is an Open Access electronic journal, we would like to give the decision to the Journal on whether we include tables 1-3 into the supplementary files or into the main text.

Moreover, the authors might want to reconsider presenting the figures in a similar scales for the sum of 1-min and 10-min bouts. This would make it easier for the reader to capture the differences of proportions between these two conditions.

Authors' response: We have produced different versions of the images, but prefer that we use the space more optimally in the way we have presented.

The authors should add more specific information to tables 4-5. Coefficients are apparently beta-coefficients? This should be mentioned. Also whether these are standardized beta-coefficients should be mentioned. Moreover, what are the specific models used in the table 5? Which variables were in the models simultaneously in the table 5?

Authors' response: Thank you for this comment. The coefficients presented in tables 4 and 5 are unstandardized regression coefficients and we have added the details into the tables 4 and 5. We have also added into the footnotes of table 5 which models and variables were used in the analyses. Table 5 comprises the results of four different generalized linear mixed effects regression models. All of these four generalized linear mixed effects regression models incorporate each participant as a random effect but their fixed effects and dependent variables vary.

The first column includes the results of the models as the dependent variable is a binary outcome (participant did or did not have a bout of MVPA lasting ≥ 10 minutes) and the second column includes the results of the models as the dependent variable is a binary outcome (participant did or did not have a bout of VPA lasting ≥ 10 minutes). The upper part of each column comprises the results from a

simple generalized linear mixed effects regression model in which the fixed effects are age, gender, BMI, and type of day. The lower part of each column comprises the results from a generalized linear mixed effects regression model in which the fixed effects are age, gender, BMI, type of day, and all of their two-way interactions.

Reviewer: 3

Reviewer Name Neville Owen

Institution and Country Baker IDI Heart and Diabetes Institute, Melbourne, Australia

Please state any competing interests or state 'None declared': None declared

In relation to question 5 above, I have raised an issue for the editor and queried the authors about what appears to be 'consent by proxy' through service providers rather than being direct consent from the study participants themselves. This might be OK with further explanation.

Authors' response: This is an important issue and that is why we have presented our detailed research plan to the Ethics Committee of Tampere University Hospital. The ethics committee did not see any problem on the use of the register data as the analysis data file extracted from the Firstbeat register neither included data for identification of the participants nor detailed data on their chronic diseases, employees or occupations, which would have given the possibility to identify some of the participants.

This is a very interesting paper that uses a novel method to identify variations in participation in moderate and vigorous physical activity in a large sample of working adults. It is well written and the methods are described with considerable clarity and precision. It is something of a blockbuster – there are far more tables and figures than one would normally encounter. It wasn't apparent to me which of the tables of figures might be deleted for the purposes of brevity.

Authors' response: Thank you for the positive comment. The scope of the descriptive paper from this large material is rather wide. We have tried to make our figures easy to read and informative and we have included the numbers of participants in each group and appropriate more detailed statistical variables in tables. There is indeed overlapping between the figures and tables 1-3; our original idea was to place tables 1-3 as supplementary files. As this is an Open Access electronic journal we would like to give the decision to the Journal on whether we include tables 1-3 into supplementary files or into the main text.

Overall, this is a significant and interesting contribution and is informative for the field. The novel measurement method used is referenced through multiple reports and documented patents that are available online.

Authors' response: Thank you for the positive comment.

What is described is, however, well outside of my particular knowledge and expertise, so it would be good if the journal had available an evaluation by someone who is expert in the physiological measurements involved in deriving activity-intensity indices from heartbeat monitoring.

Authors' response: No response from the authors.

The meticulous way in which all aspects of the paper are addressed is impressive. The scientific work described and the overall write-up of the findings are both of a very high standard, for which the authors deserve considerable credit. It's difficult to find faults – either minor or major – with their

exposition in this paper

Authors' response: Thank you for the positive comment.

This is a well written paper that describes a scientifically-novel method for determining participation in moderate and vigorous physical activity. The study has a large sample size and there is interesting descriptive information on attributes of participants. There are some matters to which the authors should attend, in order to improve some aspects of how their work is presented and interpreted:

1. Could further reassurance be provided that ethical matters were attended to appropriately. It appears that the participant-consent procedure may have been 'consent by proxy', through the service providers with whom study participants had contact. It would be reassuring for the reader if there were to be more information provided on how this consent procedure adhered to national requirements and international standards of informed consent for research study participants.

Authors' response: This is an important issue and that is why we have presented our detailed research plan to the Ethics Committee of Tampere University Hospital. The ethics committee did not see any problem on the use of the register data as the analysis data file extracted from the Firstbeat register neither included data for identification of the participants nor detailed data on their chronic diseases, employees or occupations, which would have given the possibility to identify some of the participants. This way of using anonymous analysis data files is in line with the use of national health care register, such as reimbursable medication and hospital discharge registers in Finland.

2. It seems likely that the consistent pattern lower levels of moderate and vigorous activity on working days is related to the requirement that many workers will have to sit at desks and in front of computers for long hours during their working days. There is new evidence that prolonged sitting specifically may be a significant occupational health hazard that requires attention. Given the large volume of time involved, reducing sitting time may have greater potential for improving health than might be achieved through the relatively limited opportunities that could exist for increasing moderate and vigorous physical activity. The authors allude to the likely importance of lower-intensity activity. Perhaps there could be some consideration of this in the discussion?

Authors' response: We agree that this is an interesting issue. The scope of our article is already very wide and we intend to analyze next our data in more detail concerning low intensity levels of physical activity at work and during leisure time. However, we need to note that recent published data does not consistently show an association between high work-related sitting and future increased mortality (see Holtermann A et al. Occupational and leisure time physical activity: risk of all-cause mortality and myocardial infarction in the Copenhagen City Heart Study. A prospective cohort study. *BMJ Open* 2012;2:e000556.; Hu G-C et al. Occupational versus leisure-time physical activity in reducing cardiovascular risks and mortality among ethnic Chinese adults in Taiwan. *Asia-Pacific J Public Health* 2013; DOI: 10.1177/1010539512471966.; Richard A et al. Effects of leisure-time and occupational physical activity on total mortality in NHANES III according to sex, ethnicity, central obesity and age. *J Phys Act Health* 2014; (e-pub ahead of print).), although much TV viewing (possibly due to its association with other unhealthy behaviors) predicts increased morbidity and mortality.

3. Could further consideration also be given to the recommendation that for overweight and obese individuals, moderate-intensity activity be addressed first? Given the modest amounts of MPA and VPA that are identified, particularly so for those who are overweight or obese and those who are older, might it not be more realistic and potentially more beneficial for these very inactive people to reduce their sitting time and increase their light-intensity physical activity?

Authors' response: The idea of our comment was that it may not be wise to suggest very vigorous activity to obese people as the first intervention, which is in line with your suggestion. We have now added 'or perhaps low intensity activity' to our recommendation in the discussion. However, we want to analyze the low intensity levels of physical activity in more detail later and comment this more strongly after that analysis. Now we say at the end of our discussion 'Notably, some physical activity is under the intensity level of 3 METs, which was not taken into account in our current analysis.'

VERSION 2 – REVIEW

REVIEWER	Jani Vaara National Defence University, Finland
REVIEW RETURNED	10-Oct-2014

GENERAL COMMENTS	The revision made full fills and answers the concerns I previously have raised. I suggest the manuscript to be accepted.
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REVIEWER	Tuija Tammelin LIKES - Research Center for Sport and Health Sciences, Finland
REVIEW RETURNED	29-Oct-2014

GENERAL COMMENTS	The authors have responded to the questions and comments in an adequate way and edited manuscript accordingly. No further comments or questions.
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